

REMARKS

Claims 1 - 18 are presently pending. In the above-identified Office Action, the Examiner rejected Claims 1, 3, 7, 9, 15, and 16 under 35 U.S.C. § 103(a) as being unpatentable over Minden *et al.* (A Range Resolved Doppler Imaging Sensor Based on Fiber lasers), view of Shigematsu (US Patent No. 4,948,246). Claims 4-6, 8, and 11-14 stand rejected as being unpatentable over Minden in view of Shigematsu, and further in view of other references. Claims 9, 10 (identified as Claim 14 in the Office Action), and 15 are objected to as lacking proper antecedent basis.

By this Paper, Applicant has amended Claim 1 to make the preamble more descriptive of the invention, and corrected Claims 9, 10, and 15 as necessary. For the reasons set forth more fully below, reconsideration, allowance and passage to issue are respectfully requested.

The present invention addresses the need in the art for a laser transmitter capable of producing the coherence, high power, and high bandwidth required for use in synthetic aperture lidar applications. In accordance with the invention, a synthetic aperture lidar system is taught including a mode locked laser transmitter; a receiver adapted to detect signals transmitted by the laser and reflected by an object, a mechanism for moving the laser whereby the direction of motion forms a large angle with the direction of the transmitted laser beam and a mechanism for processing the detected signals to increase cross-range resolution.

The invention is set forth in Claims of varying scope of which Claim 1, as amended, is illustrative. Claim 1 now recites:

1. A synthetic aperture lidar system comprising:
a mode locked laser transmitter;

a receiver adapted to detect signals transmitted by the laser and reflected by an object;
means for moving the laser transmitter and receiver, wherein the direction of motion forms a large angle with the direction of the transmitted laser beam; and
means for processing the detected signals to increase cross-range resolution.

None of the references, teach, disclose or suggest the invention as presently claimed. That is, none of the references, taken alone or in combination, teach, disclose or suggest a ladar system with a mode locked laser transmitter and a mechanism for processing the detected signals to increase cross-range resolution as presently claimed.

It is well known in the art that the cross-range resolution of a synthetic aperture radar or ladar is commonly expressed either as the angle between the target (i.e. any reflecting object in the scene) and the beam, or as a distance (typically normal to the direction of the beam or parallel to the direction of motion of the sensor). These quantities are essentially interchangeable, since either may be calculated from the other given the known range bin occupied by the target. In the present application, cross range resolution is clearly defined in equation 4, on page 8, as an angular measurement.

Note that cross range resolution, by either definition, is not velocity or range-rate. In a synthetic aperture radar or ladar, the velocity of the targets (generally stationary) and the sensor system are known, and the angular or linear position of the target is calculated from the known velocity and the Doppler shift of the detected signals reflected from the target.

Claim 1 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Minden *et al.* (A Range Resolved Doppler Imaging Sensor Based on Fiber lasers), view of Shigematsu (US Patent No. 4,948,246). This rejection is respectfully traversed.

Minden teaches a range-resolved Doppler laser radar that is similar to Paranto (cited in a prior Office Action) except for the choice of laser. Minden simply uses Doppler data to establish range-rate or velocity, which is then displayed as a chart of velocity versus distance, as shown in Fig. 11. Examiner states that Minden discloses “means for processing the detected signals to increase cross-range (i.e. velocity) resolution.” However, as discussed above, cross-range resolution and velocity are not the same thing. A range-resolved Doppler ladar determines velocity from the Doppler shift of the detected signals. A synthetic aperture ladar, such as the present invention, determines cross-range resolution from the Doppler shift of the detected signals and the already known velocity of the ladar system. Minden, in disclosing means for processing to do the former, does not disclose means for processing to do the latter.

Shigematsu teaches a leading vehicle detection system using a range resolved (non-Doppler) ladar with provisions for scanning the beam direction in azimuth. The Examiner contends that Shigematsu provides a beam at a large angle with respect to the direction of motion, but this contention is inconsistent with the intent of the invention to detect leading vehicles. Shigematsu determines the velocity of objects from the range-rate (i.e. the rate of change of the range) and then uses the velocity data as a filter to select only objects of interest having almost the same speed as the vehicle mounting the invention.

Section 2141 of the Manual of Patent Examining Procedure reads, in part, as follows:

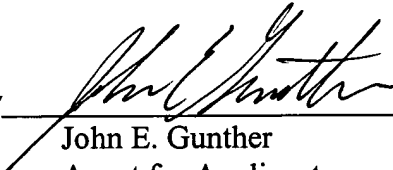
“To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make

the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure."

Applicant respectfully submits that the examiner has failed to establish a *prima facie* case of obvious with respect to Claim 1 of the present application, since the combined references do not teach or suggest all of the Claim limitations. In particular, neither of the cited reference discloses means for processing detected data to increase cross-range resolution. For that matter, neither of the references discusses cross-range resolution at all. Additionally, neither Minden or Shigematsu discuss moving the laser transmitter and receiver in a direction that forms a large angle with the direction of the transmitted laser beam. Thus applicant respectfully submits that claim 1 is allowable and requests that the rejection be withdrawn.

Applicant also submits that the claims depending from Claim 1 are also allowable. Thus, the present claims are believed to be in proper form for allowance. Accordingly, reconsideration, allowance and passage to issue are respectfully requested.

Respectfully submitted,
Maurice J. Halmos

By 
John E. Gunther
Agent for Applicant
Registration No. 43,649

Raytheon Company
P.O. Box 902
EO/E4/N119
El Segundo, CA 90245

310-647-3723
310-647-2616 facsimile